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CPSC 490

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Senior Project Proposal:

Research-Driven Curriculum Design

1. Introduction and Background

Computer science is the fastest-growing field of study in U.S. higher education. At Yale, the major has grown by 814% over the past 15 years – from 14 computer science graduates in the class of 2007 to 114 in the class of 2021. Interest in computer science among non-majors is even more striking. In September 2022, the Yale Daily News reported that "Computer science is the second-most popular major in Yale College, and total enrollment in computer science courses reached a new record high of 3,260 students for the fall 2022 semester, according to Department Chair Zhong Shao." This has coincided with new course offerings in interdisciplinary applications of computer science, such as "Python Programming for Humanities and Social Sciences," "Biomedical Software Design," and the "YData" series. Additionally, there has been a proliferation of joint majors that invite students to combine computer science coursework with their education in electrical engineering, psychology, mathematics, fine arts, and, most recently, linguistics. These trends signal that there is greater demand than ever for computer science education, specifically for courses that cater to new entrants to the field who may have little or no prior computer science experience.

These new students widely share a few perceptions about computer science as a discipline, namely that a) it has many diverse subfields; b) it is closely related to, though not

exactly the same as, programming/the tech industry; and c) it is not clear how to connect their introductory coursework to specific aspirations (study areas, industry sectors, etc.). In the paper "Undergraduate Conceptions of the Field of Computer Science," Professor Michael Hewner of the Rose-Hulman Institute of Technology discusses his research of the attitudes of students new to the discipline, including students from engineering colleges (Georgia Tech), liberal arts universities (Duke), and HBCUs (Spelman). One commonality across nearly all students was that they had "No detailed knowledge of subfields of CS." Some had only vague notions of "low-level" (OS, compilers) vs "high-level" (databases, web development) topics. Virtually all students had no concrete knowledge of entire subfields, such as vision or graphics, even if they knew that computer scientists work on self-driving cars or animation. Indeed, students share the sense that computer science studies feed into wide-ranging academic/career paths but lack specific knowledge of what those paths are and the steps required to take them. Aikenhead and Ryan (1992), Greening (1998), McGufee (2000), Carter (2006), and Guzdial (2008), arrive at similar conclusions.

2. Research

The central aim of this project is research-driven curriculum design. The ultimate goal is the rigorous specification of a new introductory computer science course, intended as a CPSC 100 (CS50) successor, that addresses the opportunities and challenges mentioned above. Specifically, this course will clarify the diverse academic/career paths that a computer science education allows, as well as the specific coursework/skillset needed to pursue them. Armed with basic programming and algorithmic analysis skills from CS50, students in this new course will receive exposure to varied subfields of CS that map to semester-long electives offered by the department, e.g. natural language processing, artificial intelligence, architecture, etc. Our vision

for this course is to accomplish this through two-week modules over the semester, with each module's contents reflecting an academic sub-domain and potential career path. This is an ambitious project, and completing it will require multiple key research components – specifically, research on Computer Science Education (CSE) and the computer science job market.

I will conduct a meta-analysis (study of studies) of CSE literature that addresses introductory computer science education, with a specific focus on student retention, non-major accommodation, and the integration of introductory curriculum into a broader department. I'll also research the curriculum pathways of other top CS programs (again with a focus on the situatedness of introductory curriculum within broader course offerings) and compile my findings into a separate report. I believe both of these sub-projects will prove useful to the Yale Computer Science department, even aside from the construction of this new course. Another research component will be an analysis of computer science-related job postings and their skill requirements. This will entail a meta-analysis of existing data collected by StackOverflow and Microsoft, as well as academic studies on the subject of industry-conscious CS curriculum design.

3. Deliverables

1) Meta-analysis of CSE introductory curriculum studies

2) Report on computer science curriculum pathways of top university programs

3) Analysis of computer science job listings

4) Curriculum for new Yale computer science course.

4. Timeline

Deliverable 1 by end of February

Deliverable 2 by mid-March

Deliverable 3 by mid-March to end of March

Deliverable 4 by end of semester, to be worked on throughout